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TITLE OF THE PRESENT INVENTION

PROJECT PLANNING SYSTEM AND METHOD FOR ACCOMMODATING AD HOC REQUESTS WITHIN A FIXED CORE DEVELOPMENT CYCLE

FIELD OF THE PRESENT INVENTION

The present invention relates generally to a project planning and management system and, more particularly, to a tool for the simultaneous production of one or more core products and specialized or custom work or other projects based on customer demands that arise on an ad hoc basis. In a preferred aspect, the present invention provides a system and method for project planning and management in a software development environment that balances fixed and variable content requests in a controlled manner.

BACKGROUND OF THE PRESENT INVENTION

Often, a production environment will involve both fixed (core) production content and variable (custom) production content. Since customized production is usually based on customer requests that arise on an irregular basis, it is difficult to forecast for purposes of resource allocation. In conventional practice, resources are typically allocated to either fixed content or variable content. This methodology, however, suffers from the drawback of under-utilized resources and slack time during periods when custom project requests fall off, and over-utilized resources and/or the loss of profitable custom work during periods when the number of custom project requests is high. Thus, it would be desirable to provide a project planning and management system or technique that accommodates both core and variable production content.

SUMMARY OF THE PRESENT INVENTION

A first aspect of the present invention is a method for managing the planning and performance of multiple projects, the multiple projects comprising one or more projects that are identified as a mandatory type, one or more projects that are identified as nonmandatory type, and one or more projects of an ad hoc type that arise intermittently and are subject to change. The method includes calculating a number of working hours available for performance of the multiple

projects; estimating the time required for completion of each project; based on the time estimates, allocating a first amount of time for performance of the mandatory projects, allocating a second amount of time for performance of the ad hoc projects, and allocating a third amount of time to be held in reserve, wherein the sum of the first, second, and third amounts of time is less than or equal to the available hours; assigning tasks associated with the projects for performance; periodically inputting an actual time spent in performing the projects and a current status of each project; based on the actual time spent and current status for each project, reestimating the time required for completing each project; for each project type, determining if there exists a time imbalance between the allocated time for completion and the reestimated time for completion; and if there exists a time imbalance, reallocating the first, second, and third amounts of time to eliminate the time imbalance.

A second aspect of the present invention is an information handling system comprising a processing system and a project planning and management system interconnected with the processing system, the project planning and management system for managing the planning and performance of multiple projects, the multiple projects comprising one or more projects that are identified as a mandatory type, one or more projects that are identified as nonmandatory type, and one or more projects of an ad hoc type that arise intermittently and are subject to change. The project planning and management system is configured to: calculate a number of working hours available for performance of the multiple projects; estimate the time required for completion of each project; based on the time estimates, allocate a first amount of time for performance of the mandatory projects, a second amount of time for performance of the ad hoc projects, and a third amount of time to be held in reserve, wherein the sum of the first, second, and third amounts of time is less than or equal to the available hours; record assignments of tasks associated with the projects for performance; periodically receive input of an actual time spent in performing the projects and a current status of each project; reestimate, based on the actual time spent and current status for each project, the time required for completing each project; determine, for each project type, if there exists a time imbalance between the allocated time for completion and the reestimated time for completion; and if there exists a time imbalance, reallocating the first, second, and third amounts of time to eliminate the time imbalance.

A third aspect of the present invention is a planning system for the planning and management of multiple projects, the multiple projects comprising one or more projects that are identified as a mandatory type, one or more projects that are identified as nonmandatory type, and one or more projects of an ad hoc type that arise intermittently and are subject to change. The planning system comprises an input means for entering project information and task information associated with each project, the project information identifying each project as being of a mandatory, nonmandatory, or ad hoc type, and the task information describing each task to be performed by users of the system and an estimated duration of each task; a work hour calculator for calculating a number of working hours available for performance of the multiple projects; an allocation engine for allocating a first amount of time for performance of the mandatory projects, a second amount of time for performance of the ad hoc projects, and a third amount of time to be held in reserve, wherein the sum of the first, second, and third amounts of time is less than or equal to the available hours; a schedule preparation engine for preparing a schedule of tasks for performance, the schedule comprising an estimated time for the performance of each task; a time tracking system for recording actual time spent in performing the projects and a current status of each project; a time imbalance calculator for detecting a difference between actual time spent in performance of the projects and the estimated time for performance of the projects; and an allocation modification engine for reestimating the time required for completing each project based on the actual time spent and current status for each project and reallocating time to eliminate any time imbalance detected by the time imbalance calculator.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the description of the preferred embodiments given below, serve to explain the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The following is a brief description of each drawing used to describe the present invention, and thus, are being presented for illustration purposes only and should not be limitative of the scope of the present invention, wherein:

FIG. 1 is a block diagram of the project planning and management system **100** according to the present invention;

FIG. 2 is a flow chart outlining an exemplary method of the present invention;

FIG. 3 is a flow chart illustrating an exemplary method of reallocating time in implementing the present invention; and

FIG. 4 illustrates a computer information handling system operable to embody the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The present invention provides a project planning and management system and method that accommodates multiple modes of product development and production. Generally, production is divided into fixed or planned production and variable production, although further divisions are also contemplated. Planned production content refers to production of products having a generally fixed time schedule, such as core product releases that are planned for release at a particular time. Planned production releases can also be scheduled for release on a regular basis, such as yearly, twice a year, quarterly, monthly, and so forth. Variable production content refers to specific or custom requests for products that tend to arise on an irregular or intermittent basis. Although the present invention will be described primarily by way of reference to the preferred embodiment of production within a software development environment, it will be recognized that the present invention is also applicable to other production environments having both fixed and variable content.

The present invention uses a concept of running two virtual factories simultaneously. The first factory handles the core product releases planned for release at a fixed time or at fixed time intervals. The second factory handles custom projects that tend to arise on an ad hoc basis. Thus, factory one and factory two each have different priorities, schedules, and planning processes. However, the factories use the same or similar production processes, thus

allowing the factories to be virtual, i.e., the workers (e.g., software engineers) are a part of the same enterprise and can work back and forth on projects assigned to both factories, depending on assignments, schedules, and time allocations generated by the planning system in accordance with this teaching.

Factory one handles core product releases planned for regular or fixed release, e.g., twice a year. This factory uses an up front planning process, e.g., based on client, prospect, and market needs. One or more planners for factory one, such as a product planner, marketing person, or the like, select and prioritize content to be included in the product releases. The factory one content includes both mandatory and opportunity or nonmandatory items. The mandatory items are scheduled for inclusion in the factory one product. Nonmandatory items are not initially scheduled for inclusion in the factory one product, but can become mandatory items if time becomes available, for example, when factory one is over achieving the mandatory list or an occasional lull occurs in the factory two production schedule. Work in factory one typically consists of changes, enhancements, or new modules for existing products or new products for planned release.

Factory two handles custom solutions or other specialized work that varies on an ad hoc basis. These projects typically arise overnight and delivery is often needed within a short amount of time.

FIG. 1 shows a block diagram of a project planning and management system **100** according to the present invention. In the depicted embodiment, the planning system **100** comprises one or more data terminals or workstations **110** up to *N* data terminals or workstations **112** interconnected with a project management system **120** via a network **114**. Network **114** may be, for example, a local area network (LAN), metropolitan area network (MAN), wide area network (WAN), and the like, and interconnections thereof. Each of the workstations **110-112** may be a stand alone computer information handling system, such as a personal computer, minicomputer, mainframe computer, and the like, capable of operating independently of the network system **114**. Likewise, the project management system **120** can be implemented as modules, e.g., software, firmware, or hardware modules, or any combination thereof, in a computer-based information handling system of a type as described above in reference to workstations **110-112**. A hardware system **400** generally representative of exemplary hardware

architecture of workstations **110-112** and an information handling system operable to implement the project management system **120** is illustrated in FIG. 4. Optionally, workstations **110-112** and network **120** are omitted and project management system **120** is implemented in a standalone information handling system as described above, for example, hardware system **400** (FIG. 4).

Workstations **110-112** are manipulated by one or more users, e.g., a planner, manager such as a department manager or project manager, etc., to enter necessary project information into the project management system **120**. The information includes, for example, the available supply of work hours, activity allocation rules or guidelines on how time is to be allocated between different project types and to be spent on various steps or tasks associated with each project.

The project management system **120** includes an I/O section **122** which transmits and receives data to and from the workstations **110-112**. A resource calculator **124** calculates an expected or estimated supply of available working hours based on information entered via the I/O section **122**. The project management system **120** also includes an activity rules and parameters section **126** for storage of various time usage rules and parameters input via the I/O section **122**.

A time allocation section **128** determines the amount of resources determined to be available by the resource supply calculator **126** that is to be allocated to each specific project type and, within each project type, to each project based on the rules and parameters section **120**. Preferably, exceptions to the rules and parameters of section **128** or other adjustments for particular projects or specific tasks associated with a particular project can be made via I/O section **122**. Activity rules and parameters section also includes allocation rules for allocating time between factory one, factory two, and reserve time.

In a preferred embodiment, each project is broken down into identifiable tasks required for project performance and completion, and each task is associated with an expected or estimated time for completion within the activity rules module **126**. The sum of the individual tasks for a given project can then be used as the total time estimated for performing the project.

Based on the available production hour supply, selected projects, and the activity allocation rules, an allocation is made within allocation module **128** to factory one, factory two, and reserve time. Based on the allotted time, a schedule prepare section **130** prepares a task

based schedule. The prepared schedule is output via I/O section **122**. The schedule preferably shows the tasks selected for performance and the allocated time for each tasks. The tasks are preferably grouped according to department, project, etc.

A time tracking system **132** tracks the actual time spent on each project and the current status of each project. Actual time and status information is input via I/O section **122** by users of the system, such as persons performing the project or persons otherwise responsible for performance of the project. This information is input on periodic basis, e.g., daily, weekly, biweekly, monthly, etc., depending on, for example, the size of the projects, the time frame requirements of the projects, and acceptable tolerances in such time frames. The status of the project can be determined in a number of ways, such as inputting workers' or managers' estimates of additional time required to complete the project or reach some milestone, inputting milestones which have been reached, and so forth. In the above described preferred embodiment, wherein each project is broken down into identifiable tasks having an estimated or expected time for completion, status is determined based on the completed and uncompleted tasks and the associated allocation rules or estimates.

A time imbalance determine section **134** uses the input actual time and status data to reestimate the time required for completion of the projects and to determine how much of the allocated time remains. By comparing the reestimate with the remaining allocated time, it is determined whether a time imbalance exists. Preferably, time is allocated on a task by task basis and the remaining allocated time is determined by totaling the time allocated for yet uncompleted tasks.

A time imbalance can be determined to exist via a number of methods. A time imbalance is said to exist for a project type (e.g., all factory one projects or all factory two projects) when the reestimated time required for completion of all projects of a given type differs (or differs by more than a preselected amount) from the remaining allocated time for that project type. Likewise, a time imbalance for a project is said to exist if the reestimated time required for completion of a given project differs (or differs by more than a preselected amount) from the remaining allocated time for that project. Other methods for determining whether there is a time imbalance are also possible. For example, all activities, tasks, or projects within a given department can be grouped together, with a time imbalance being said to exist if the reestimated

time required for completion of all projects of a given type differs (or differs by more than a preselected amount) from the remaining allocated time for that project type. In the event that there is no time imbalance, the schedule is not modified, although schedule prepare section **130** can output a schedule with updated status information via I/O section **122**.

Upon the detection of a time imbalance by time imbalance calculator **134**, an allocation modification section **136** modifies the time allocations to bring the reestimated time and the reallocated time into balance.

In one embodiment, time is reallocated on a project by project basis. For example, if a positive time imbalance is determined to exist for one or more particular projects, i.e., the reestimated time required for project completion is less that the allocated time remaining (i.e., the project was initially overallocated time), the plan is modified by allocation modification section **136** so that extra time is reallocated to one or more projects for which there is a negative time imbalance, i.e., the reestimated time required for project completion is more than the allocated time remaining (i.e., the project was initially underallocated time). If there are no positive time imbalances or if the positive time imbalances are insufficient to completely offset the negative time imbalances, reserve time is reallocated as necessary so as to offset the negative time imbalance. Likewise, if there are no negative time imbalances or if the total positive time imbalances are sufficient to offset the negative time imbalances, any excess time can be reallocated to the pool of reserve time. Alternatively, or in addition to reallocating time to the reserve pool, other reallocations of net positive time imbalances may also be made. For example, since allowing the pool of reserve time to become too large might result in a less than optimal use of the work hour resource, a positive time imbalance can be reallocated to factory one projects. By reallocating time to factory one projects, nonmandatory projects can be re-identified as mandatory projects to be included in the core product release, thus adding features or additional value to the core product release. Additionally, or alternatively, reallocating time to mandatory projects allows the product release date to be advanced. Increasing the quality and/or advancing the release date of the factory one product serves to increase overall customer satisfaction. Likewise, additional time resulting from positive time imbalances can be reallocated for performance of factory two ad hoc projects. In this manner, additional profitable custom projects can be accepted and incorporated

into the work schedule. Additionally, or alternatively, existing factory two projects can be completed early.

In another embodiment, time is reallocated on a department by department basis. For example, if a positive time imbalance is determined to exist for all projects within a particular department, i.e., the department was initially overallocated time, the plan is modified by allocation modification section **136** so that extra time is reallocated to one or more other departments for which there is a negative time imbalance, i.e., the department was initially underallocated time. If there are no positive time imbalances or if the departmental positive time imbalances are insufficient to completely offset the negative departmental time imbalances, reserve time is reallocated as necessary so as to offset the negative time imbalance. Likewise, if there are no negative time imbalances or if the total departmental positive time imbalances are sufficient to offset the negative time imbalances, any excess time can be reallocated to the pool of reserve time. In this manner, a planner or department manager can effectively reallocate time among projects within a department before any reallocations between departments or project types are made.

In another embodiment, time is reallocated based on project type. For example, if a positive time imbalance is determined to exist for all projects of a particular type, e.g., mandatory or ad hoc, the plan is modified by plan modification section **136** so that extra time for one project type is reallocated to another project type for which there is a negative time imbalance. If there are no positive time imbalances or if the project-type positive time imbalances are insufficient to completely offset the negative departmental time imbalances, reserve time is reallocated as necessary so as to offset the negative time imbalance. Likewise, if there are no negative time imbalances or if the total project type positive time imbalances are sufficient to offset the negative time imbalances, any excess time can be reallocated to the pool of reserve time. In this manner, a planner or department manager can effectively reallocate time among all projects of a given type before any reallocations between project types are made.

Preferably, project management system **120** further includes an other contingencies section **138** for the input of exceptions to the activity rules, for example, due to estimation error, newly discovered defects in the product design or production process, and so forth.

Project management system **120** also includes a database **140** or other storage medium for storage of input values, schedules, allocations and modifications, etc. Data stored in

database **140** is output via I/O section **122** in selectable formats for analysis. Advantageously, the data stored for prior production cycles can be stored and used to improve or refine the activity rules for future projects. Database **140** can be located at any convenient location on the network.

Referring now to FIG. 2, there is shown a flow chart outlining a project planning and management method **200** of the present invention. In step **210**, activity rules and parameters for production and nonproduction activities are input. In step **220**, supply hour data are input by a user, such as a planner, manager, or the like, using a terminal **110-112**. The data can be input, for example, using an on-screen worksheet, or an on-screen questionnaire, a series of interactive prompts, and the like. Working hours available for production are calculated by subtracting the hours required from nonproduction activities, such as vacation, training, etc., from the total supply of hours. Nonproduction hours can be estimated using stored or input activity rules based on standard or average values for each nonproduction activity, or can be based on previous experience, for example, based on values stored in database **138** from previous production cycles. The number of hours available for production are calculated in step **230** by subtracting the nonproduction hours from the supply hours.

Factory one and factory two project data are input in step **240** and the production hours are allocated between factory one, factory two, and reserve time in step **250**. The initial allotment is based on the activity rules and preferably falls within a predetermined range. According to an exemplary, nonlimiting embodiment, 40-75% of production hours is allotted to factory one content, 15-30% for factory two content, and 15-25% are held in reserve. In a preferred embodiment, the time is also allocated based on the activity rules for each identifiable task or subproject making up the projects selected for performance. Alternatively, allocation may be made on a departmental basis, with further allocations within each department being at the discretion of a user, such as a department manager or the like.

In step **260**, specific tasks required for performance of the selected projects are assigned to workers. A work schedule is created in step **270**. In step **280**, the status and actual time spent on each task is input. In step **290**, if all projects are complete, the process ends. If all projects are not complete (step **290**), it is determined whether a time imbalance exists at step **300**.

If a time imbalance does not exist at step **300**, it is determined at step **310** whether there any new projects to be added. If no new projects have been added (step **310**), the status is

updated and the process returns to step **280**. If new projects have been added at step **310** the process proceeds to **330**. The new projects are integrated and the process returns to step **250** for allocation, assignment, etc. New projects for integration include recent (ad hoc) requests for a new factory two product, nonmandatory factory one projects that have been reclassified as mandatory items, projects required for correction of newly discovered defects in a current product or project, and so forth.

If a time imbalance does exist at step **300**, the process proceeds to step **340** and it is determined whether there are any new projects to be added. If no new projects have been added (step **340**), the time is reallocated in step **350** and the process returns to step **270**. If there are new projects, the process proceeds to step **330** wherein new products are integrated into the production schedule. The process then returns to step **250** and the production hours are reallocated to incorporate the new projects and to eliminate the time imbalance detected in step **300** and continues as described above.

Referring now to FIG. 3, step **300** of FIG. 2 is shown in greater detail in accordance with an exemplary embodiment. In step **3001**, it is determined whether there is a negative time imbalance. If there is a negative time imbalance at step **3001**, the process proceeds to step **3002** and it is determined whether reserve time is available. If reserve time is available, it is assigned for reallocation at step **3003** to balance the time, and the process proceeds to step **340**. If there is no reserve time available at step **3002**, the process proceeds to step **3004** and reallocation can be performed by redistributing remaining time as necessary to minimize the effect of the negative time imbalance. Also, a warning can be output at step **3004** and, if the negative time imbalance is significant, a replan may be necessary.

If there is no negative time imbalance in step **3001**, it is determined in step **3005** whether there is a positive time imbalance. If there is no positive time imbalance at step **3005**, the process continues to step **310**.

If there is a positive time imbalance at step **3005**, it is determined in step **3006** whether the reserve time has fallen below some threshold value, e.g., due to previous time reallocations, newly integrated projects, etc. If the reserve time has fallen below some threshold value, the positive time imbalance, or some portion thereof, is added to bring the reserve time up to the threshold level. The threshold level is some preselected value above which maintained

reserve time is regarded as an inefficient allocation of working hours. The process then proceeds to step **3008** and it is determined if there is still a positive time imbalance. If no, the process continues to step **340**.

If there is still a positive time imbalance at step **3008**, or if the reserve time was above the threshold level (step **3006**), the process continues to step **3009**. At step **3009**, it is determined whether there are any custom project requests that can be integrated into the current plan. If yes, the positive time imbalance, or some portion thereof, is assigned for reallocation to factory two for accommodation of the additional custom work in step **3010**. The process continues to step **3011** and it is determined if there is still a positive time imbalance. If no, the process continues to step **340**.

If there is still a positive time imbalance at step **3011**, or if there was no custom work available (step **3009**), the process continues to step **3012**. At step **3012**, it is determined whether there are any nonmandatory (opportunity) projects that can be integrated into the current plan. If yes, the positive time imbalance, or some portion thereof, is assigned in step **3013** for reallocation to factory one for accommodation of nonmandatory projects. The process continues to step **3014** and it is determined if there is still a positive time imbalance. If no, the process continues to step **340**.

If there is still a positive time imbalance at step **3014**, or if there was no opportunity work that could be accommodated at the time (step **3012**), the process continues to step **3015**. At step **3015**, it is determined whether early release of the factory one product is possible. If yes, the positive time imbalance, or some portion thereof, is assigned in step **3016** for reallocation to factory one to allow for early release of the factory one product. The process continues to step **3017** and it is determined if there is still a positive time imbalance. If no, the process continues to step **340**.

If there is still a positive time imbalance at step **3017**, or if early release would not be possible or feasible even with the additional time (step **3015**), the process continues to step **3018** and the additional time is added to the reserve pool. The process continues to step **340**.

Referring now to FIG. 4, an information handling system operable to embody the present invention is shown. The hardware system **400** shown in FIG. 4 is generally representative of the hardware architecture of a computer-based information handling system of the present

invention, such as data terminals **110-112**, and an information handling system embodying project planning and management system **120**. The hardware system **400** is controlled by a central processing system **402**. The central processing system **402** includes a central processing unit such as a microprocessor or microcontroller for executing programs, performing data manipulations and controlling the tasks of the hardware system **400**. Communication with the central processor **402** is implemented through a system bus **410** for transferring information among the components of the hardware system **400**. The bus **410** may include a data channel for facilitating information transfer between storage and other peripheral components of the hardware system. The bus **410** further provides the set of signals required for communication with the central processing system **402** including a data bus, address bus, and control bus. The bus **410** may comprise any state of the art bus architecture according to promulgated standards, for example industry standard architecture (ISA), extended industry standard architecture (EISA), Micro Channel Architecture (MCA), peripheral component interconnect (PCI) local bus, standards promulgated by the Institute of Electrical and Electronics Engineers (IEEE) including IEEE 488 general-purpose interface bus (GPIB), IEEE 696/S-100, and so on. Other components of the hardware system **400** include main memory **404**, and auxiliary memory **406**. The hardware system **400** may further include an auxiliary processing system **408** as required. The main memory **404** provides storage of instructions and data for programs executing on the central processing system **402**. The main memory **404** is typically semiconductor-based memory such as dynamic random access memory (DRAM) and/or static random access memory (SRAM). Other semi-conductor-based memory types include, for example, synchronous dynamic random access memory (SDRAM), Rambus dynamic random access memory (RDRAM), ferroelectric random access memory (FRAM), and so on. The auxiliary memory **406** provides storage of instructions and data that are loaded into the main memory **404** before execution. The auxiliary memory **406** may include semiconductor based memory such as read-only memory (ROM), programmable read-only memory (PROM), erasable programmable read-only memory (EPROM), electrically erasable read-only memory (EEPROM), or flash memory (block oriented memory similar to EEPROM). The auxiliary memory **406** may also include a variety of nonsemiconductor-based memories, including, but not limited to, magnetic tape, drum, floppy disk, hard disk, optical laser disk, compact disc read-only memory (CD-ROM), write once compact disc (CD-R), rewritable compact disc (CD-RW), digital

versatile disc read-only memory (DVD-ROM), write once DVD (DVD-R), rewritable digital versatile disc (DVD-RAM), etc. Other varieties of memory devices are contemplated as well. The hardware system **400** may optionally include an auxiliary processing system **408** which may include one or more auxiliary processors to manage input/output, an auxiliary processor to perform floating point mathematical operations, a digital signal processor (a special-purpose microprocessor having an architecture suitable for fast execution of signal processing algorithms), a back-end processor (a slave processor subordinate to the main processing system), an additional microprocessor or controller for dual or multiple processor systems, or a coprocessor. It will be recognized that such auxiliary processors may be discrete processors or may be built in to the main processor.

The hardware system **400** further includes a display system **412** for connecting to a display device **414**, and an input/output (I/O) system **416** for connecting to one or more I/O devices **418**, **420**, up to *N* number of I/O devices **422**. The display system **412** may comprise a video display adapter having all of the components for driving the display device, including video memory, buffer, and graphics engine as desired. Video memory may be, for example, video random access memory (VRAM), synchronous graphics random access memory (SGRAM), windows random access memory (WRAM), and the like.

The display device **414** may comprise a cathode ray-tube (CRT) type display such as a monitor or television, or may comprise an alternative type of display technology such as a projection-type display, liquid-crystal display (LCD), light-emitting diode (LED) display, gas or plasma display, electroluminescent display, vacuum fluorescent display, cathodoluminescent (field emission) display, plasma-addressed liquid crystal (PALC) display, high gain emissive display (HGED), and so forth.

The input/output system **416** may comprise one or more controllers or adapters for providing interface functions between the one or more I/O devices **418-422**. For example, the input/output system **416** may comprise a serial port, parallel port, universal serial bus (USB) port, IEEE 1394 serial bus port, infrared port, network adapter, printer adapter, radio-frequency (RF) communications adapter, universal asynchronous receiver-transmitter (UART) port, etc., for interfacing between corresponding I/O devices such as a keyboard, mouse, track ball, touch pad, joystick, track stick, infrared transducers, printer, modem, RF modem, bar code reader, charge-

coupled device (CCD) reader, scanner, compact disc (CD), compact disc read-only memory (CD-ROM), digital versatile disc (DVD), video capture device, TV tuner card, touch screen, stylus, electroacoustic transducer, microphone, speaker, audio amplifier, etc. The input/output system **416** and I/O devices **418-422** may provide or receive analog or digital signals for communication between the hardware system **400** of the present invention and external devices, networks, or information sources. The input/output system **416** and I/O devices **418-422** preferably implement industry promulgated architecture standards, including Ethernet IEEE 802 standards (e.g., IEEE 802.3 for broadband and baseband networks, IEEE 802.3z for Gigabit Ethernet, IEEE 802.4 for token passing bus networks, IEEE 802.5 for token ring networks, IEEE 802.6 for metropolitan area networks, and so on), Fibre Channel, digital subscriber line (DSL), asymmetric digital subscriber line (ASDL), frame relay, asynchronous transfer mode (ATM), integrated digital services network (ISDN), personal communications services (PCS), transmission control protocol/Internet protocol (TCP/IP), serial line Internet protocol/point to point protocol (SLIP/PPP), and so on. It should be appreciated that modification or reconfiguration of the hardware system **400** of FIG. 4 by one having ordinary skill in the art would not depart from the scope or the spirit of the present invention.

Although the invention has been described with a certain degree of particularity, it should be recognized that elements thereof may be altered by persons skilled in the art without departing from the spirit and scope of the invention. One of the embodiments of the invention can be implemented as sets of instructions resident in the main memory **404** of one or more computer systems configured generally as described in FIG. 4. Until required by the computer system, the set of instructions may be stored in another computer readable memory such as the auxiliary memory of FIG. 4, for example in a hard disk drive or in a removable memory such as an optical disk for utilization in a DVD-ROM or CD-ROM drive, a magnetic media for utilization in a magnetic media drive, a magneto-optical disk for utilization in a magneto-optical drive, a floptical disk for utilization in a floptical drive, or a memory card for utilization in a card slot. Further, the set of instructions can be stored in the memory of another computer and transmitted over a local area network or a wide area network, such as the Internet, when desired by the user. Additionally, the instructions may be transmitted over a network in the form of an applet that is interpreted after transmission to the computer system rather than prior to transmission. One

skilled in the art would appreciate that the physical storage of the sets of instructions or applets physically changes the medium upon which it is stored electrically, magnetically, chemically, physically, or optically so that the medium carries computer readable information.

The description above should not be construed as limiting the scope of the invention, but as merely providing illustrations to some of the presently preferred embodiments of this invention. In light of the above description and examples, various other modifications and variations will now become apparent to those skilled in the art without departing from the spirit and scope of the present invention as defined by the appended claims. Accordingly, the scope of the invention should be determined solely by the appended claims and their legal equivalents.